BEFORE THE NORTH CAROLINA UTILITIES COMMISSION
DOCKET NO. E-2, SUB 1142

In the Matter of:		
Application of Duke Energy Progress,	**)**	**DIRECT TESTIMONY OF**
LLC, for Adjustment of Rates and	**)**	**PAUL J. ALVAREZ**
Charges Applicable to Electric	**)**	**ON BEHALF OF**
Service in North Carolina	**)**	**ENVIRONMENTAL DEFENSE FUND**

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I. INTRODUCTION

Q. Please state your full name and business address.

A. My full name is Paul J. Alvarez. My business address is Wired Group, Post Office Box 150963, Lakewood, Colorado, 80215.

Q. By whom are you employed and in what capacity?

A. I am the President of the Wired Group, a consultancy specializing in distribution utility performance and value creation.

Q. What is the purpose of your direct testimony?

A. I am testifying on behalf of The Environmental Defense Fund ("EDF") regarding the Power/Forward Carolinas investment program referenced in this case. I recommend that the Commission establish a distinct proceeding to enable Commission review of, and stakeholder participation in, so-called "grid modernization" plans before investments are made.

My testimony will demonstrate that Commission review and stakeholder participation in the Company's proposed grid modernization plan is warranted. I believe that a dedicated, transparent, Commission-led proceeding on grid modernization plans, similar to those led by regulators in many other states, will improve the capability prioritization, investment selection, and outcomes (in terms of benefits delivered) of any grid modernization investments the Company might make.

Q. Please describe your professional and educational background.

A. My career in the electric utility industry began 16 years ago with Xcel Energy, one of the largest investor-owned utilities in the U.S. After a series of product management roles of progressive responsibility for large corporations, including Motorola's Communications Division (now owned by Google), Baxter Healthcare, Searle Pharmaceuticals, and Walgreens, I served Xcel Energy as product development manager. In this role I oversaw the development of new demand-side management (DSM) programs for residential and commercial and industrial customers, as well as programs and rates in support of voluntary renewable energy purchases and renewable portfolio standard compliance.

In 2008 I left Xcel Energy to establish a utility practice for boutique sustainability consulting firm MetaVu. While at MetaVu I utilized the DSM program benefit measurement and verification (M&V) experience I gained at Xcel Energy to lead two comprehensive, unbiased evaluations of smart grid deployment performance. To my knowledge these are the only two comprehensive, unbiased evaluations of smart grid deployment performance completed to date. The results of both were part of regulatory proceedings in the public domain, including an evaluation of the SmartGridCity™ deployment in Boulder, Colorado completed for Xcel Energy in 2010,[1] and an evaluation

[1] *SmartGridCity™ Demonstration Project Evaluation Summary*. Exhibit MGL-1 to the testimony of Michael G. Lamb in the Matter of the Public Service Company of Colorado Application for Approval of SmartGridCity Cost Recovery. Filed with the Colorado PUC in 11A-1001E on December 14, 2011. Alvarez et al. Report dated October 21, 2011.

of Duke Energy's Cincinnati-area deployment completed for the Ohio Public Utilities Commission in 2011.[2] Both deployments included both grid and meter modernization.

I started the Wired Group in 2012 to focus exclusively on distribution utility performance measurement and utility customer value creation. Wired Group clients include consumer and environmental advocates, regulators, utility suppliers, and industry associations. Since 2012 my team and I have completed detailed, formal reviews of grid modernization plans from nine investor-owned utilities (IOUs) in regulatory proceedings, and less formal reviews of grid modernization plans from six other IOUs for clients outside of regulatory proceedings or out of professional interest. In addition to leading the Wired Group, I teach post-graduate courses in my fields of expertise. I teach "Renewable Energy Commercialization: Electric Technologies, Markets, and Policy" at the University of Colorado's Global Energy Management Program. I also teach sessions on distribution utility performance measurement and grid modernization value creation at Michigan State University's Institute for Public Utilities, a program dedicated to educating new regulators and staff on utility industry concepts.

Finally, I am the author of <u>Smart Grid Hype & Reality: A Systems Approach to Maximizing Customer Return on Utility Investment</u>. The book describes the challenges of translating smart grid investments into economic and environmental benefits for customers, and offers optional organizational, operational, customer engagement, rate design, and regulatory solutions. I received an undergraduate degree in finance and

[2] *Duke Energy Ohio Smart Grid Audit and Assessment*. Public Utilities Commission of Ohio Staff Report, public version, filed in 10-2326-GE-RDR on June 30, 2011. Alvarez et al.

marketing from Indiana University's Kelley School of Business in 1983, and a master's degree from the Kellogg School of Management at Northwestern University in 1991.

Q. Have you testified previously before the North Carolina Utilities Commission?

A. No.

Q. Have you testified previously before other state utility commissions?

A. Yes. I have testified or prepared reports for my clients regarding distribution business investments, benefits, costs, and performance measurement in cases before state utility commissions in California, Colorado, Kansas, Kentucky, Maryland, Massachusetts, New Hampshire, and Ohio. My full CV is provided as Appendix A to this testimony.

Q. How is your testimony organized?

A. My testimony will demonstrate that a distinct proceeding to enable Commission review and stakeholder participation in grid modernization plans is warranted as described below.

I will begin by describing the reasons why a distinct proceeding is warranted. There are several reasons, including: 1) the large size and distinct character of grid modernization investments; 2) the potential for stakeholder participation to improve alignment between the Company's grid modernization investments and stakeholders' priorities; 3) the inadequacy of the "used and useful" standard to protect consumer and environmental interests once grid modernization investments have been made; and 4) the high likelihood

that Commission review will deliver a better benefit-cost ratio for customers, communities, and the environment.

With these descriptions I do not mean to imply that grid modernization investments are not worthwhile. Indeed, I believe grid modernization offers many potential economic, reliability, and environmental benefits to customers and communities, and that the economic benefits to customers can exceed customer costs in ideal circumstances and conditions. I am supportive of grid modernization investments that increase conservation, provide customers with new products and services, safely and reliably integrate higher levels of renewable generation, and reduce rates.

However, my experience indicates that the benefits customers and the environment actually receive from grid modernization investments vary greatly from utility to utility. I will therefore use the second section of my testimony to discuss specific grid modernization capabilities with large benefit potential, the sources of benefit variation, and associated concerns I have about the Company's grid modernization plan given the limited plan information provided to date.

Finally, I will describe common grid modernization plan review processes in use by utility regulators in other states, including forward test years, certificates for public convenience and necessity, and specially-convened proceedings. I will then summarize my testimony and close with my conclusions.

II. COMMISSION REVIEW OF GRID MODERNIZATION PLANS IS WARRANTED

Q. Why do you believe a distinct proceeding for grid modernization plans is warranted?

A. I believe Commission review and stakeholder participation prior to grid modernization investment is warranted for several reasons, which I will describe more fully below:

- Proposed grid modernization investments are very large and distinct in character from customary, business-as-usual grid investments;
- Commission review with stakeholder participation will better align grid modernization capabilities and investments with Commission and state priorities;
- Application of the "used and useful" standard to assess the prudence of grid modernization investments after large investments have been made is inadequate to protect consumer and environmental interests; and
- It is likely Commission review will deliver a better grid modernization benefit-cost ratio for customers, communities, and the environment than if no such review had been conducted.

Grid Modernization Investments are Very Large and Distinct in Character from Customary Grid Investments, Warranting Prior Commission Review and Stakeholder Participation.

Q. Please support your contention that the large size of grid modernization investments warrants prior Commission review and stakeholder participation in grid modernization plans.

A. In testimony, the Company reports that it plans to invest $1.6 billion to modernize its grid over the next five years[3] as the beginning of a $13 billion state-wide investment program which the Company has labeled "Power/Forward."[4] Given that the Duke Energy Progress and Duke Energy Carolinas serve about 3.2 million customers in North Carolina, Power/Forward investments will amount to over $4,000 per customer.[5] To place this amount into perspective, at year end 2015, Duke Energy Progress' entire gross distribution plant in service amounted to $3,782 per customer.[6] The grid modernization plan could therefore double, in just ten years, the distribution asset levels the Company's predecessors built up over 100 years.[7] I believe an asset expansion of this magnitude, the cost of which customers will be required to repay over the next few decades, warrants prior Commission review and stakeholder participation.

The proposed grid modernization investments are as large as the generation investments for which the Commission has prior review and an established stakeholder participation process (the Certification of Public Convenience and Necessity, or CPCN, process). Compare the $1.6 billion in proposed grid modernization investments to the generation-related investments driving the Company's current request for a 14.9% rate increase as listed in Table 2 below.

[3] NCUC E-2, Sub 1142. Direct testimony of Duke Energy Progress witness David B. Fountain. Page 35, line 6.
[4] Ibid. Page 34, line 22
[5] $13 billion divided by 3.2 million customers equals $4,062.50 per customer.
[6] Gross distribution plant data per FERC Form 1, 2015; customer count data per EIA Form 861, 2015.
[7] Carolina Power & Light was formed in 1908.

Table 1: Costs of large generation-related investments highlighted by the Company in current rate case

Description	Amount (in millions)	Citation
Cost of generation projects highlighted by Duke Energy Progress: $1.76 B		
New natural gas plants	$416	Fountain testimony, p. 9
New solar plants	184	Ibid, p. 12
Coal plant emission controls	141	Ibid, p. 13
Coal ash basin closures	978	Ibid, p. 14
Harris nuclear development	40	Ibid, p. 15

To summarize, the large size of grid modernization investments clearly warrants upfront Commission review and stakeholder participation in grid modernization plans to ensure just and reasonable rates.

Q. Please support your contention that the distinct character of grid modernization investments warrants upfront Commission review and stakeholder participation in grid modernization plans.

A. The Company's proposed grid modernization plan consists of investments which are over and above the $3.2 billion for customary grid investments requested.[8] Customary grid investments -- including poles, wires, transformers, substations, and the like – are much different from the type of grid modernization investments available today. Grid modernization investments are not "customary" in that the capabilities they offer and the technologies available to deliver them are so distinct from customary grid needs as to

[8] NCUC E-2, sub 1142. Direct testimony of Robert M. Simpson III. Pate 25, lines 7-21.

warrant a much higher level of Commission review and stakeholder participation than would make sense for customary grid investments.

Q. Please explain.

A. As mentioned by the Company in its testimony, "customary" grid investments are driven by economic growth and development, and by replacing equipment as it fails. Historically, there has been a direct correlation between grid investment and customer and community benefit. Accommodating economic growth and development, and replacing equipment as it fails, provides customers and communities with direct benefits. Failure to accommodate economic growth and development, or failure to replace equipment as it fails, directly harms customers and communities. There are simply few if any alternatives to, or choices within, these customary grid investments in poles, wires, transformers and substations. So opportunities for Commission review or stakeholder participation to improve upon customary grid investments are limited or zero.

Contrast this with so-called "grid modernization" investments, which the Company admits are over and above its customary level of grid investment. The value attributed to the new capabilities the Company plans to enable, be they incremental reliability improvements, more detailed usage information, or the reliable accommodation of distributed renewable generation,[9] is likely to vary widely by the goals chosen to be advanced by grid modernization, by customer type, and by stakeholder. I also note that grid modernization capabilities which do deliver value to all customers and the

[9] NCUC E-2, Sub 1142. Direct Testimony of Robert M. Simpson III. Page 26, lines 2-12.

environment, such as conservation and demand response, are not included in the Company's grid modernization plan descriptions. In addition, multiple technology options are available to deliver each new capability, and each technology engenders its own pros and cons and is associated with its own benefits and costs. I have found that some technology choices, such as in meter communication networks and customer energy usage data access, can even constrain customer benefits.

Perhaps most critically, as I describe later in this section, the benefits actually delivered to customers and the environment from grid modernization investments vary widely from utility to utility based on a number of factors within utility control. For example, I know of no IOU which has voluntarily maximized the conservation or demand response benefits available from smart meters. With grid modernization, investment alone does not deliver direct community and customer benefits, as is the case with customary grid investments. Instead, the level of benefit delivered to customers from grid modernization investments is entirely dependent on what a utility does with the capabilities enabled by the investments. This variation makes grid modernization investments distinctly different from customary grid investments, and warrants a separate proceeding for Commission review and stakeholder participation prior to making the investment.

Q. Have you reviewed the Smart Grid Technology Plan (SGTP) filed by the Company on October 3, 2016, or the SGTP update filed on May 5, 2016?

A. Yes. In my opinion the SGTP and update are inadequate to provide the Commission or stakeholders with confidence that the Company's grid modernization plan maximizes

economic, reliability, and environmental benefits at the least amount of cost. As just one example, though Duke Energy Progress alone plans to invest $1.6 billion from 2017 through 2021 for its share of the first phases of the Power/Forward grid modernization plan,[10] the Company's SGTP, filed with the Commission in October 2016, offered details on just $20.76 million in capital projects from 2017 through 2019.[11] The Company's SGTP update consisted of three paragraphs explaining that it had not made a final decision on AMI, that the AMI capital estimate was $276.4 million, and that AMI could reduce O&M costs by $9.3 million over a 5-year deployment period.[12] The fact that this is the only information provided for a $1.6 billion investment proposal serves as a clear indication that a separate proceeding, including Commission review and a stakeholder participation process, is necessary.

On a related note, though the Commission has clearly and accurately identified the critical relationship between grid modernization and integrated resource planning via its rule to produce SGTPs on a bi-annual basis,[13] the SGTP rule has not generated the type of information or process necessary to review and assess the proposed grid modernization investments in a way that assures 'just and reasonable' rates. The SGTP rule was clearly not intended to serve as a robust stakeholder participation process for investments of the magnitude the Company is proposing. Due to the large size and distinct character of proposed grid modernization investments, I believe a more significant Commission review and stakeholder participation process is clearly warranted.

[10] NCUC E-2, Sub 1142. Direct testimony of David B. Fountain. Page 35, lines 2-8.
[11] Duke Energy Progress 2016 Smart Grid Technology Plan. October, 3, 2016.
[12] Supplemental Information – 2016 Smart Grid Technology Plans. Docket E-100, Sub 147. May 5, 2017. Page 8.
[13] NCUC Rules Chapter 8, "Electric Light and Power". Article 11, "Resource Planning and Certification". R8-60.1

Stakeholder participation will better align grid modernization capabilities and investments with stakeholder priorities, warranting a separate proceeding.

Q. Why do you believe stakeholder participation will better align Company grid modernization capabilities and investments with stakeholder priorities?

A. Utility company managers are incented to maximize shareholder value within the limits of federal and state laws and rules. Share prices grow with increases in income, and income grows with increases in regulated investment under the cost-based ratemaking model in use today. IOUs therefore have a significant incentive to increase regulated investment, including grid investment. That is not to say that IOU incentives always drive investment choices contrary to ratepayer and stakeholder interests, but that incentives could d drive IOUs to make choices which are contrary to ratepayer and stakeholder interests in some situations.

The financial incentive to make grid investments also encourages IOUs to assign greater value to new grid capabilities than customers may be willing to pay for new grid capabilities. The higher the value ascribed, the easier it is for an IOU to make the business case to regulators that proposed grid investments are justified. As an example, consider the undergrounding of overhead power lines, which is extremely expensive, as strategy to improve reliability. Speaking hypothetically, while an IOU may be willing to spend billions of dollars to secure a 5% improvement in reliability, many customers may not be as willing to pay such a price. A 5% improvement in SAIDI equates to only 7.1

minutes annually in the Company's case.[14] The benefit-cost ratio of reliability improvements is a subject ideally suited for Commission review and stakeholder participation due to differences in priorities and capability valuations.

Resilience can serve as another example of misaligned incentives which Commission review and stakeholder participation could address. For example, a preliminary Power/Forward capital budget the Company provided in discovery allocates almost $500 million, or 24% of the budget, on undergrounding of overhead lines.[15] While improving grid resilience through undergrounding sounds attractive, the high cost of undergrounding per customer served, as well as the opportunity costs of such spending compared to other options, must be taken into account. Nor is undergrounding a panacea, as cables severed by a construction crew proved at the height of the tourist season last summer, when Hatteras and Ocracoke islands were shut down for a week. While undergrounding reduces the grid's exposure to wind and ice, it increases exposure to flooding, which was extensive for Hurricane Matthew. The appropriate extent of undergrounding is exactly the type of investment which should be reviewed by the Commission with stakeholder participation due to differences in priorities and capability valuation. This has been recognized in Virginia, another state prone to hurricane-induced resilience concerns. In 2015, the Virginia State Corporation Commission rejected as too expensive (relative to benefits) a $2 billion plan by Dominion to bury about 4,000 miles

[14] U.S. EIA Form 861, 2015. "SAIDI without Major Event Days", DEP, North Carolina (141 minutes) x 5%.

[15] "DEP Power/Forward Carolinas (North and South) 2017-2021 Budget". Dated August 18, 2017. Provided by the Company in response to EDF INT 02, Question 2.

of outage-prone tap lines. Instead, the Virginia SCC approved 412 miles of overhead line undergrounding at a cost of $122 million after a stakeholder participation process.[16]

To summarize, while investing capital is a significant incentive for IOUs, the Commission's priorities are to maximize available economic, reliability, and environmental benefits at the least possible grid modernization cost. The differences in priorities and capability valuations that may arise between the Company and different stakeholders in grid modernization justify a process with upfront review by the Commission and stakeholder participation. With no defined process, the Commission will be unable to assess whether the $13 billion in spending, for which customers will be responsible to pay, meets objectives set by the Commission. In my opinion, this alone serves as justification for staking this issue outside the rate case with a defined process for Commission review and stakeholder participation in grid modernization plans.

Q. Why do you believe differences in grid modernization priorities and benefit valuations between the Company and stakeholders warrant stakeholder participation in grid modernization plans?

A. Stakeholder participation has proven to be an effective approach to bridging the difference between IOU and stakeholder priorities and capability valuations. This is likely the reason the Commission's rules require a stakeholder participation process (the CPCN process) for new generation and transmission investments. I see no reason why a

[16] *Dominion would owe $133M if not for rate freeze*. Richmond Times-Dispatch. September 5, 2017.

stakeholder participation process wouldn't help bridge the differences between the Company and stakeholder in grid modernization plans.

With stakeholder participation and Commission review, the best ideas from all parties about the priority capabilities to deliver (with full knowledge of the benefits and costs of various available value streams), and the best strategies to maximize benefits from capabilities, can be pursued collectively. I believe stakeholder participation and Commission review will deliver dramatically better outcomes compared to relying solely on the Company's investment perspective.

The "used and useful" standard is inadequate to protect consumer and environmental interests once investments have been made, warranting a grid modernization proceeding.

Q. Please describe the "used and useful" standard, and how monopoly regulators have used it to protect consumer interests.

A. The used and useful standard has been used by monopoly regulators to protect consumer interests for many decades. Though the used and useful standard first evolved in the 1940s, in 1980 the D.C circuit court clarified ". . . an item may be included in rate base only when it is 'used and useful' in providing service."[17] The used and useful standard prevents IOUs from growing profits by investing more in physical assets than is necessary to serve customers. Regulators can deny cost recovery from customers for

[17] Tennessee Gas Pipeline Co. v. FERC, 606 F.2d 1094, 1123 (D.C. Cir. 1979), cert. denied, 445 U.S. 920 and 447 U.S 922 (1980)

IOU investments which are not "used and useful", thereby discouraging unnecessary IOU investment and protecting consumers from associated cost increases.

Q. What challenges do grid modernization investments present for the application of the used and useful standard?

A. As I will demonstrate in the next section of my testimony, grid modernization investment choices are myriad and varied. I will also demonstrate that the level of value delivered by these investments is highly variable and almost entirely dependent on utility actions which cannot be assured. Variation in both investment choices and value delivered present a challenge to the used and useful standard. For example, the advanced meters the Company proposes to install will be "used" to collect usage data for billing purposes. However, since the Company already has meters to fulfill this function, will the advanced meters be "useful"? What incremental benefits, such as conservation, can the advanced meters deliver which increases their utility? Will the Company commit to taking the actions required to maximize advanced meters' conservation capabilities despite the Company's throughput incentive?

The Commission could theoretically employ the used and useful standard to deny cost recovery if it determines the Company is not maximizing the conservation (or other) value streams from advanced meters once deployed. But since the advanced meters will be "used," it may be difficult for the Commission to identify a legal basis for denying cost recovery. Furthermore, as a very large investment ($276.4 million), disallowance of cost recovery could adversely impact the Commission's ability to ensure "that facilities

necessary to meet future growth can be financed by the utilities operating in this State . . ."[18] This example illustrates that it will be practically difficult for the Commission to deny cost recovery once grid modernization investments are made. I believe it would be far better for the Commission to review the investments and consider stakeholder input in advance of deployment of the technologies. The Commission could then develop appropriate guidance for the Company and apply appropriate protections for consumer and environmental interests prospectively.

Q. How will Commission and stakeholder participation in grid modernization plans moderate the inadequacies in the used and useful standard?

A. By participating in grid modernization planning, the Commission and stakeholders can help ensure the Company "begins with the end in mind," and establishes use cases, performance requirements, and priorities which will result in better capability and technology choices and more appropriate post-deployment actions by the Company. An analogy from the product development world can help illustrate my point.

Product developers from companies like 3M, Procter & Gamble, Hewlett-Packard, and Apple always develop a "product requirements" document to "sell" management on new product ideas. The document specifies the customer needs a new product will satisfy, the capabilities the product must exhibit, the performance standards (speed, volume, etc.) the capabilities must meet, and exactly how the capabilities will be used (use cases).

[18] North Carolina General Statutes, Chapter 62-2, Paragraph (a)4a.

Management uses product requirement documents to help inform decisions to commit (or withhold) funds for the development of specific new products.

I believe product requirements and use cases are examples of plan evaluation tools the Commission could employ in a dedicated grid modernization proceeding. I believe grid modernization plan reviews should be rigorous, and that stakeholders can contribute to such rigor. The value of rigorous Commission review and stakeholder participation in grid modernization plans is real, not theoretical. For example, the Company's affiliate in Ohio (Duke Energy Ohio) recently submitted a request to invest $143 million to replace over 600,000 smart meters installed just a few years ago, along with the associated communications network and data processing software. The metering system technologies were chosen and deployed by Duke Energy Ohio without prior regulatory review or stakeholder input. In testimony filed with the Ohio PUC, one of Duke Energy Ohio's largest justifications for the replacement plan was the fact that the recently-installed metering systems are not capable of providing the billing-quality interval data necessary for time-varying rates.[19] That such an obvious smart meter capability was not vetted and secured in advance is a testament to the value of a rigorous Commission review and stakeholder engagement proceeding for grid modernization plans. I am not suggesting the Company's current grid modernization plan contains such deficiencies, but I relate this example solely to illustrate the potential value of Commission reviews and stakeholder participation in a separate proceeding from the rate case.

[19] PUCO 17-32-EL-AIR. Direct Testimony of Donald L. Schneider, Jr. Page 15, lines 15-20.

Q. Are there other ways a distinct grid modernization proceeding can help moderate inadequacies in the used and useful standard?

A. Yes. I believe a distinct grid modernization proceeding should include the development of a performance measurement program to help ensure the benefits anticipated from grid modernization investments are realized on behalf of customers and the environment. A performance measurement program focused on the outcomes of grid modernization investments, including quantified targets for reliability improvements; operating cost reductions; lost revenue reductions; and increases in conservation, demand response, and distributed renewable generation hosting capacity, would moderate inadequacies in the used and useful standard. Pre-deployment baselines and target timeframes should also be specified as part of a performance measurement program designed with stakeholder input. A post-deployment performance measurement program can help ensure the realization of grid modernization consumer and environmental benefits in a way the used and useful standard is simply not equipped to deliver.

It is likely stakeholder participation will deliver a better customer benefit-cost ratio from grid modernization investments than no such participation, warranting a separate proceeding.

Q. Why do you believe stakeholder participation will deliver a better customer benefit-cost ratio from grid modernization investments than no such participation?

A. Most regulators will require an IOU to provide a benefit-cost analysis which justifies grid modernization investment. In my experience, IOUs' grid modernization benefit-cost analyses suffer from many common deficiencies. A distinct grid modernization

proceeding prior to deployment provides stakeholders with an opportunity to identify such deficiencies and propose remediations for regulator consideration. Such remediations could include post-deployment performance plans and other customer and environmental benefit assurance measures.

Q. Has the Company provided a benefit-cost analysis for its grid modernization plan?

A. No. However Duke Energy Carolinas did include a benefit-cost analysis for the advanced metering portion of its grid modernization plan in its SGTP update filed May 5, 2017.

Q. Does the benefit-cost analysis provided by Duke Energy Carolinas indicate a favorable benefit-cost analysis for customers?

A. Yes, the advanced meter benefit-cost analysis provided by Duke Energy Carolinas in its SGTP update does indicate that the economic benefits of advanced metering will exceed the costs. But as of now there is no distinct proceeding, and therefore no stakeholder opportunity, to examine the Duke Energy Carolinas benefit-cost analysis for deficiencies. I also note that Duke Energy Progress has provided no benefit-cost analysis for its proposal to invest $1.6 billion in grid modernization from 2017 to 2021. The lack of information on the Company's $1.6 billion proposal, combined with the lack of a distinct proceeding for formal stakeholder inquiry, concerns me given my experience that the customer and environmental benefits utilities actually deliver from grid modernization investments can be highly variable.

Q. What are some of the more common deficiencies you've found in IOUs' grid modernization benefit-cost analyses?

A. Common deficiencies I've found in IOUs' grid modernization benefit-cost analyses include under-estimated customer costs, missing benefits which IOUs should be pursuing as part of their grid modernization efforts, and the inclusion of benefits which are often unrealized by customers to the extent estimated. I have found one, two, or all three of these deficiencies in every grid modernization benefit-cost analysis I have examined.

Q. How do IOUs' grid modernization benefit-cost analyses commonly underestimate customer costs?

A. IOUs develop grid modernization cost estimates from an IOU's perspective; that is, what the IOU must spend to execute its grid modernization plan. This is much different from what customers must pay for grid modernization, which is always higher. In addition to reimbursing an IOU's costs, customers must also pay carrying costs, including interest expense, IOU profits, income taxes on IOU profits, and property taxes on IOU investments. IOUs exclude these customer payments from their benefit-cost analyses, though they can inflate the costs customers must pay by 20% or more. Another common example of under-estimated costs is the write-down of the book value of any assets, such as existing meters, retired prematurely to make way for modern grid assets such as advanced meters. IOUs eventually request recovery of these asset write downs, as well as for profits they would have earned on the assets in rate base over time, from customers. Duke Energy Progress appears to be preparing for such a request in its request to establish a regulatory asset for meters that will be replaced under the grid

modernization program.[20] IOUs generally exclude these write down costs, and associated carrying costs, from benefit-cost analyses.

When the ultimate cost to customers is underestimated in a benefit-cost analysis, the expectation to find and deliver a certain level of economic benefits from grid modernization investments – a level which will deliver a favorable benefit-cost ratio for customers – is lowered. I feel this ultimately results in artificially low expectations in grid modernization benefit delivery, and corresponding reductions in the level of benefits demanded by stakeholders and delivered by IOUs post deployment. As just one example, underestimated costs might enable an IOU to indicate a positive benefit-cost ratio from grid modernization without the benefits of conservation and demand response, though my experience indicates this is highly unlikely. I believe more accurate customer cost estimates from stakeholder examination to be one of the benefits of a distinct grid modernization proceeding with Commission review.

Q. Please describe the benefits IOUs should be pursuing as part of grid modernization efforts which you have found to be missing in many IOU benefit-cost analyses.

A. As the Commission is aware, IOUs in most states (including North Carolina) have an economic incentive to distribute more electricity than the amount estimated in a rate case. Electric rates recover distribution costs, which are largely fixed, via a price per kWh sold, the volume of which varies. As a result, any fall in kWh sales volumes harms utility distribution profits, while any increase in kWh sales volume grows utility distribution

[20] NCUC E-2, Sub 1142. Direct testimony of Laura A. Bateman. Page 19, lines 9-13.

profits. In fact, the economic incentive for utilities to distribute ever-increasing levels of electricity is so prevalent that it has been given a name: the throughput incentive. I believe the throughput incentive is responsible for the exclusion of conservation programs, including voltage optimization, from many utilities' grid modernization plans, and conservation benefits from many utilities' benefit-cost analyses. I believe Commission review of grid modernization plans, to include stakeholder participation, can help ensure the conservation potential of grid modernization investments are recognized and realized.

Q. Please describe the benefits IOUs include in benefit-cost analyses which are often unrealized by customers to the extent anticipated.

A. Almost all utilities cite reductions in operating costs and electricity theft as benefits from advanced meters in their grid modernization benefit-cost analyses. While I agree that significant economic benefits are available from these sources, I note that rate case timing has a lot to do with the recognition of these benefits by customers in the form of lower rates.

As the Commission is aware, reductions in operating costs and electricity theft will not reduce customer rates without a rate case based on test year books which include these economic benefits. Until a rate case is conducted using Company books which reflect these economic benefits, these benefits will accrue to shareholders, not ratepayers. Since the Company controls the timing of rate cases, it is possible for several years to elapse before these economic benefits are reflected in lower rates for customers. A distinct

proceeding would enable the Commission to consider the nature and extent of this issue and design appropriate mechanisms to address it, thereby improving the benefit-cost ratio for customers.

Q. Are there other examples of benefits IOUs include in benefit-cost analyses which are often unrealized by customers to the extent anticipated?

A. Yes. For utilities which do include conservation programs in grid modernization plans, I've noted a tendency for utilities to sub-optimize conservation program benefits post deployment. Again, I hold the throughput incentive responsible. Ways in which a utility might subtly sub-optimize conservation benefits available from grid modernization include:

- Failure to optimize investment in, or to maximize the conservation benefits of, integrated volt-var control (IVVC);
- Failure to maximize participation in the proposed usage alert program;
- Failure to maximize participation in time-varying rates (which research indicates offer conservation benefits as well as demand response benefits);
- Failure to maximize participation in "pay as you go" programs (which research indicates offers conservation benefits).

A distinct proceeding would allow stakeholder input on such issues and provide the Commission with opportunities to design appropriate measures in response. Again, I suggest a performance measurement program which might emerge from such a

proceeding can increase the likelihood that the customer and environmental benefits anticipated in a grid modernization benefit-cost analyses will be realized.

III. GRID MODERNIZATION OFFERS MANY POTENTIAL BENEFITS, THOUGH SUCCESS VARIES WIDELY BY UTILITY

Q. Please describe the potential benefits your experience indicates are available from grid modernization investments.

A. I believe several types of benefit are potentially available to communities, customers, and the environment from grid modernization investments. These include increased conservation and demand response; reductions in operating costs and lost revenues; incremental reliability improvements; and increased capacity to accommodate distributed renewable generation (called "hosting capacity"). In addition, if one defines grid modernization to include the undergrounding of power lines, I imagine grid resiliency improvements are a potential benefit too. My definition of grid modernization does not include the undergrounding of power lines, as underground cabling has been routinely practiced by utilities for several decades.

Q. Please describe the potential conservation benefits from grid modernization.

A. I believe conservation offers one of the single largest sources of potential economic and environmental benefit from grid modernization. I've seen conservation benefits delivered thorough four primary grid modernization capabilities: IVVC; time-varying rates; "pay as you go" programs; and usage alert programs.

Q. What is integrated volt-VAr control, and how does it conserve electricity?

A. To understand how integrated volt-VAr control (also known by many other names, including IVVC) works, one must understand voltage, and how customers' electric devices respond to changes in voltage. Voltage is analogous to the pressure of water in a pipe. The higher the voltage, the more electricity is delivered per unit of time for a given size/type of wire. At lower voltages, less electricity is delivered per unit of time for a given size/type of wire.

Electric devices to be sold in North America are designed to work within a standard range of 110 to 120 volts, and utilities are likewise required to deliver electricity at between 110 and 120 volts. Some types of customers' electric devices use more energy when that energy is supplied at 120 volts than when that energy is supplied at 110 volts. Examples of these devices, which are known as resistive loads, include all forms of electric lighting as well as all forms of electric heating elements (such as those found in electric water heaters, dishwashers, clothes dryers, and hair dryers.)

When voltages are supplied by utilities at less than 110 volts, equipment can perform erratically. Computers can shut down and lights can flicker. To avoid such problems, utilities generally err on the high side of the voltage range (114 to 126 volts), which causes resistive loads to use more electricity than they otherwise would. IVVC helps address this situation by leveling voltage variation all along a circuit. When voltage is more consistent, utilities need no longer err on the high side of the voltage range to avoid low voltage issues. By reducing the average voltage all along a circuit, all resistive loads on that circuit use less electricity. IVVC can therefore be used as a conservation tool

which reduces line losses on the grid and also reduces the amount of energy used by customers. Both of these outcomes reduce customers' bills.

Utilities have been making voltage more consistent for decades through periodic manual adjustments of settings on circuit equipment such as voltage regulators, load tap changers, and capacitor banks. But rather than sending out a truck and technician to make such adjustments once or twice a year, if that frequently, IVVC uses software and wireless remote controls to optimize voltage device setting adjustments automatically and continuously in response to changing grid conditions, 24 hours a day, 365 days a year. IVVC is therefore much more effective at voltage leveling than manual methods.

Of course IVVC software, circuit equipment, communications, and wireless remote controls come at a cost. But research indicates that an effectively designed and conscientiously applied IVVC capability can reduce electricity use by as much as 2.5 percent annually on the circuits on which it is installed.[21] What's more, IVVC requires no customer action to secure conservation benefits. IVVC also offers economic benefits by improving power factor (the VAr in integrated volt-VAr control), though these are smaller than the voltage benefits. IVVC also facilitates increased adoption of PV solar generation by moderating the voltage fluctuations such generation can cause.

[21] "Distribution Efficiency Initiative". Report on a test of automated voltage control mechanisms on 31 circuits at 10 substations in the Pacific Northwest. Leidos Engineering LLC (formerly R.W. Beck) and the Northwest Energy Efficiency Alliance. November 26, 2013. Table E-2, Page E-2.

Q. Did the Company describe plans to implement IVVC for conservation in its rate case or in the bi-annual smart grid technology plan (SGTP) the Commission requires of the Company?

A. The Company's SGTP indicates Duke Energy Carolinas is pursuing pre-scale deployment of IVVC for conservation, but has not finalized any costs or benefits of deploying the system at full scale.[22] Neither the Company's rate case nor SGTP appear to make any commitment to deploying IVVC for conservation despite the significant customer and environmental benefits available.

Q. How does grid modernization enable time-varying rates, and how do such rates increase conservation?

A. The Company, like most utilities, considers advanced metering infrastructure (AMI) to be a cornerstone of grid modernization. Among other features, AMI meters record energy use in very small intervals of time (among many other capabilities). In turn, this enables time-varying pricing, or the application different rates for different hours of the day or different days of the year. Pricing signals can be used to encourage customers to reduce electric use when system supply is tight. This is called demand response, and is discussed more fully below as a distinct (and large) potential benefit from AMI.

Though time-varying rates have been designed as a demand response tool, research indicates that conservation results from their use as well. A survey of multiple controlled

[22] Duke Energy Progress 2016 Smart Grid Technology Plan. October, 3, 2016. Page 31.

studies of time-varying rates found an average reduction in energy use of 4% among customers being billed on time-varying rates.[23]

Q. Did the Company provide information on time-varying rates for residential customers or their potential conservation benefits in its rate case or SGTP?

A. No.

Q. What are "Pay As You Go" programs, and how do they improve conservation?

A. Though the specifics vary slightly by utility, pay as you go programs require customers to pay for electricity in advance, rather than paying for electricity used after the fact on a monthly bill. Participating customers typically make small payments weekly, establishing credit balances on their accounts which are depleted as energy is used. Customers receive feedback regarding the amount of the credit remaining. It is thought that this feedback, combined with customer interest delaying their next payment as long as possible, has a conservation effect. In fact, research consistently shows a 10% to 11% reduction in usage when customers switch from traditional post-payment to pay-as-you-go programs.[24]

Q. Did the Company describe plans to implement pay-as-you-go programs in its rate case or SGTP?

[23] C. King and D. Delurey. "Efficiency and Demand Response: Twins, siblings, or Cousins?". Public Utilities Fortnightly. March, 2005.
[24] Ozog, Michael. "The Effect of Prepayment on Energy Use". Integral Analytics, Inc. research commissioned by the DEFG Prepayment Working Group. March, 2013.

A. The Company lists its "Prepaid Advantage" program as one which it will be able to offer upon completion of their AMI installations and Customer Information System upgrades in rate case testimony. However, the Company does not commit to offering Prepaid Advantage, nor does the Company include any associated conservation benefit in confidential AMI benefit analyses provided in discovery.

Q. What are usage alerts, and how do they improve conservation?

A. Usage alerts are a customer satisfaction effort proposed by the Company as part of their AMI deployments. In most such programs, customers register by supplying contact information (mobile phone number, land line number, or e-mail address) and a target budget for their monthly electric bill to their utility. A utility will apply an algorithm to daily usage readings from AMI meters to estimate customers' next bills at various points throughout a month. When any of these estimates indicate a customer's next bill will exceed the target budget set by the customer, an alert is sent via text message, recorded voice message, or e-mail message.

The Company described usage alerts as a customer benefit of its grid modernization plan rather than a conservation benefit. This may be appropriate, as no research on the conservation impact of such programs has been completed to my knowledge. But it is logical that usage alerts would have a conservation impact, and as a result I highly recommend the introduction of such programs with AMI deployments. In fact, I believe aggressive marketing efforts should be employed to secure as great a number of program

registrations as possible, thereby maximizing customer economic and environmental benefits.

Q. Did the Company's rate case or SGTP mention usage alerts as part of its grid modernization plans?

A. The Company lists usage alerts as one program which it will be able to offer upon completion of the AMI installations and Customer Information System upgrades. However, the Company does not commit to offering usage alerts, nor does the Company include any associated conservation benefit in confidential AMI benefit analyses provided in discovery.

Q. Please describe the potential demand response benefits from grid modernization.

A. Properly designed and implemented, the time-varying rates enabled by AMI offer another significant source of economic and environmental benefit through demand response. Demand response uses price signals to encourage customers to reduce electric use when system supply is tight (high prices). Research has shown various forms of time-varying rates, and in particular critical peak price (CPP) and peak-time rebate (PTR) rates, to be highly effective at reducing electricity use during peak electric demand periods. In fact such reductions average over 20% in a survey of 74 studies of the impact of time-varying rates.[25] By reducing the generation, transmission, and distribution investments required to meet demand at peak times, demand response can deliver significant benefits to

[25] A. Faruqui and J. Palmer. "The Discovery of Price Responsiveness: A Survey of Experiments Involving the Dynamic Pricing of Electricity." CDI Quarterly. Volume 4, Number 1. April, 2012. Page 9.

customers by deferring associated rate increases. However, the benefits delivered to customers from time-varying rates and associated demand response vary dramatically from utility to utility. In my experience, the size of economic benefit from demand response is dependent upon three factors as presented in Figure 1 below.

*Figure [SEQ Figure * ARABIC]: Determinants of demand response (CPP/PTR rate) benefit size*

CPP/PTR Benefit Size = Number of Participating Customers x Average Size of Demand Response x Value per Unit of Demand Reduced

Demand response may one day improve a utility's ability to accommodate growing levels of intermittent renewable generation as well. Using a particular type of time-varying rate called real-time pricing, customers can be alerted to low generation supply resulting from changes in cloud cover or wind conditions through price signals. Real-time pricing can help utilities accommodate more renewable generation at a lower cost by reducing back-up generation requirements, and by encouraging energy use during times when renewable generation is plentiful (thus avoiding dumping, storage, and other costs).

Q. What can utilities do to increase the benefits delivered by AMI via time-varying rates?

A. Utilities can do a lot to increase the benefits delivered by AMI via time-varying rates. Probably the most important is to increase the number of participants through default application of CPP or PTR rates. In a default scenario, all customers are placed on a CPP or PTR rate by default. Customers can choose to be placed on a traditional flat rate instead, but must take action (contacting the utility) to do so, called "opting out." Research indicates that no more than 16% of customers will opt-out of a default time-varying rate, meaning that the default application of CPP or PTR rates delivers a minimum 84% participation rate. If a utility makes CPP or PTR rates available on an opt-in basis, in which customers must take action (contacting the utility) to be placed on a CPP or PTR rate, research indicates participation will be 11% at best.[26]

Utilities can also increase the benefits from CPP or PTR rates by facilitating customer response to high-priced periods. Research indicates that the use of automated tools, or "enablers", helps customers reduce their use by an extra 50% in response to price signals.[27] These enablers, such as wireless communicating thermostats operated remotely via smart phone, are already available at a reasonable cost.

Utilities can offer these devices to customers, and even offer to control them on customers' behalves, as part of demand response programs. The Commission may also wish to consider the potential for third parties to offer such programs in recognition of the fact that energy management services do not comprise a natural monopoly. In such a

[26] A. Todd, P. Cappers, and C. Goldman. "Residential Customer Enrollment in Time-based Rate and Enabling Technology Programs: Smart Grid Investment Grant Consumer Behavior Study Analysis." Lawrence Berkeley National Laboratory, LBNL-6247E. Figure 11, "Summary of Recruitment Rates for Different Time-Based Rate Offers." Page 24.
[27] Faruqui and Palmer, page 9.

scenario, third party energy managers might require the capability to securely access customers' usage data in a standardized, automated manner when authorized by customers. Smart phone applications which access customers' usage data to help them manage energy use and time-varying rate participation are already available at low cost or no cost. The Green Button Alliance has already developed a standardized, automated, secure approach to data access called "Connect My Data." Connect My Data is currently in use in California, is in the process of being implemented in Illinois, New York, Colorado and New Jersey, and is being considered in cases currently open in Massachusetts and Texas.

Q. Did the Company's rate case or SGTP cite time-varying rates, "opt-out" CPP or PTR rate offers, demand response enablers, demand response programs, third party energy management services, or implementation of the Green Button Alliance's Connect My Data standard?

A. No.

Q. Please describe the potential operating cost benefits of grid modernization.

A. There are several sources of potential operating cost reductions from grid modernization. As Duke Energy Carolinas shows in its smart grid technology update filed on May 5, AMI offers many operating cost benefits, including reductions in meter reading costs, meter service orders, and metering operations costs. The Company claims these benefits, combined with reductions in lost revenues, are sufficient to deliver a favorable benefit-cost ratio to customers from AMI.

Q. In its rate case or SGTP, did the Company describe any performance assurances or performance metrics related to operating cost reductions?

A. No.

Q. In its rate case or SGTP, did the Company describe the timing for, or methods by which, such operating cost reductions will be reflected in customers' rates, such as through a rate case?

A. No.

Q. Please describe the potential lost revenue collection benefits of grid modernization.

A. There are several sources of potential lost revenue reduction benefits from grid modernization. As Duke Energy Carolinas shows in its SGTP update filed on May 5, these include better identification of theft, meter failures, and meter set-up errors. The SGTP update indicates that reductions in lost revenue represent the largest single source of benefit from AMI.

Q. In its rate case or SGTP, did the Company describe any performance assurances or performance measures related to lost revenue reductions?

A. No.

Q. In its rate case or SGTP, did the Company describe the timing for, or methods by which, such lost revenue reductions will be reflected in customers' rates, such as through a rate case?

A. No.

Q. Please describe the potential reliability benefits of grid modernization.

A. My research indicates that grid modernization does offer potential improvements in reliability. In my research I've found that small improvements in reliability can be secured by interrogating meters for their power status in storm situations. My research indicates that more significant reliability improvements can be secured through increased circuit sectionalization and construction of new line ties for "back feed" options.

Q. Did the Company's rate case or SGTP describe plans to utilize grid modernization investments to improve reliability as you describe?

A. Yes, the Company's rate case testimony does describe plans to use the methods I describe to improve reliability through grid modernization.

Q. In its rate case or SGTP, did the Company quantify the reliability performance improvements it will secure through grid modernization investments?

A. No.

Q. Please describe the potential benefits from increasing the grid's ability to host distributed and utility-scale renewable generation.

A. Earlier I described how the real-time pricing enabled by AMI could help accommodate more renewable generation, be it distributed or utility-scale. Regarding distributed renewable generation specifically, grid modernization investments can help increase the

capacity of the grid to accommodate more such resources than it might otherwise be able. Increases in what is called "hosting capacity"[28] can be achieved through increased visibility to grid conditions in real time via sensing devices placed throughout the grid, and through software which helps grid operators analyze grid condition data to make better grid reconfiguration decisions in response to outages or in preparation for grid maintenance and construction activities.

Large amounts of research and analysis have been conducted in recent years about the economic, reliability, and environmental benefits of distributed renewable generation, and I will not attempt to summarize or debate those here. Suffice it to say that the state of North Carolina has a renewable portfolio standard of 12.5% of electricity sold by 2021. Notwithstanding existing net metering rules, to the extent the state is able to meet the standard with capital invested by customers in rooftop solar, increases in hosting capacity may help North Carolina meet the standard in a more cost-effective manner than might otherwise be the case.

Q. Did the Company's rate case or SGTP describe plans to utilize grid modernization investments to increase its capacity to host distributed renewable generation?

A. No.

[28] According to the Electric Power Research Institute, hosting capacity is defined as "the amount of DER (distributed energy resources) that can be accommodated without adversely impacting power quality or reliability under existing control configurations and without requiring infrastructure upgrades". Hosting capacity is expressed as a range due to a variety of factors which influence it, including distributed generation types, locations in relationship to loads, and even one's definition of "adverse impact".

IV. COMMON GRID MODERNIZATION PLAN REVIEW PROCESSES USED BY REGULATORS IN OTHER STATES

Q. What are some of the common grid modernization review processes in use by public utility commissions in other states?

A. There are several processes state regulators use to review grid modernization plans. Unfortunately none of these are currently available in North Carolina, representing a deficiency which the Commission can correct. The processes include the use of forward test years in rate cases; the application of certifications for public convenience and necessity (CPCNs) to grid modernization investments; and specially-convened grid modernization proceedings.

Q. Please describe how the use of a forward test year in rate cases enables regulatory review of grid modernization plans.

A. States employing forward test years in rate cases have a built-in mechanism to review grid modernization plans. An IOU forecasts spending in the forward test year in order to calculate new rates which offer IOU management a fair opportunity to earn an authorized rate of return for shareholders. If grid modernization investments are anticipated, they are necessarily included in the capital spending forecasts used to calculate rates. These forecasts present regulators and stakeholders with an opportunity to review and challenge grid modernization investment decisions and to question post-deployment benefit optimization plans. In my experience, grid modernization benefit-cost analyses are

always a critical component of forward test year rate cases which incorporate grid modernization investment requests. These grid modernization benefit-cost analyses are developed by IOUs voluntarily, or through the routine course of stakeholder engagement in rate case proceedings.

Q. What state commissions currently utilize forward test years in rate cases?

A. State utility commissions in Alabama, California, Connecticut, Florida, Georgia, Hawaii, Maine, Michigan, Minnesota, Mississippi, New York, Oregon, Rhode Island, and Wisconsin currently allow IOUs to utilize forward test years in determining customer rates.[29]

Q. Please describe how some states apply the CPCN process to grid modernization investments.

A. Almost all state commissions require a CPCN process (Certificate of Public Convenience and Necessity) to enable stakeholder participation in generation and transmission construction decisions. Most states have excepted customary distribution investments from CPCN requirements based on the notion that such investments "are in the ordinary course of business". However, the practice of applying the CPCN process to large, non-customary distribution grid modernization investments seems to be growing. In addition, some IOUs invoke CPCN processes voluntarily, even when not required. I believe these IOUs do so to reduce the risk that grid modernization assets will be stranded (i.e., their

[29] M. Lowry et al. "Forward Test Years for U.S. Electric Utilities". Report prepared by Pacific Economics Group Research LLC for the Edison Electric Institute. August, 2010. Figure 1, page 34.

costs will not be permitted to be recovered in rates in an "after the fact" review). As one example, Duke Energy Kentucky presented its advanced metering plan for consideration to the Kentucky Public Service Commission via a CPCN absent a requirement to do so.

Q. What state commissions have applied the CPCN process to grid modernization?

A. The first state commission to apply the CPCN process to grid modernization was the Colorado PUC. In a widely followed case in 2009, the Colorado commission rejected Xcel Energy's request to recover $42 million in cost for the IOU's SmartGridCity® grid modernization demonstration project in the city of Boulder without prejudice. Instead the Colorado commission ordered that the IOU could file a CPCN in an attempt to recover prudently incurred grid modernization costs. The Colorado commission determined that grid modernization investments were "not in the ordinary course of business" based on investment size, uniqueness, and elaborate financing, and that the commission's rules and associated definitions regarding CPCN requirements did therefore apply. The decision went on to state that applying the CPCN process to grid modernization investments ". . . will allow the Commission to examine whether the costs incurred are prudent and in the public interest, and to monitor these costs in the future."[30]

Q. How are state commissions initiating and conducting specially-convened grid modernization proceedings?

[30] Colorado PUC 09AL-0299E. "Order Addressing Phase 1 and ECA Issues". Colorado PUC Decision C09-1446. Paragraphs 186-188, page 59.

A. State commissions generally convene special grid modernization proceedings when state legislation requires regulators to "encourage" utilities to invest in their grids. State regulators generally find that in the absence of other mechanisms, such as forward test years and CPCNs, a specially-convened grid modernization proceeding is the best way to ensure cost effective grid modernization. Most state grid modernization legislation includes some language requiring that grid modernization investments proposed by IOUs be "cost effective" in the judgement of regulators.

Q. What state commissions have initiated and/or conducted specially-convened grid modernization proceedings?

A. Illinois, Indiana, Massachusetts, and Pennsylvania have all passed grid modernization legislation to which regulators responded with specially-convened grid modernization proceedings. (In Pennsylvania, legislation to date has been limited to smart meters.) In each of these instances, regulators required grid modernization (or smart meter) investment proposals from each IOU, with individual proceedings established for each.

The much-followed Reforming the Energy Vision proceeding in New York State was established without legislative initiative. There, IOUs are encouraged to propose grid modernization investments in rate cases (which do involve the use of forward test years). The Hawaii PUC also requested grid modernization plans from its IOUs without legislative initiative. The New York and Hawaii IOUs are currently preparing specific grid modernization investment proposals for review in these rate cases and proceedings.

Several other state commissions are establishing more general grid modernization proceedings which do not address IOU-specific investment proposals. These proceedings are educational in nature, and designed to build awareness and understanding of approaching grid operations and business challenges as initial components of statewide grid development strategy and planning exercises. Examples of these include California (Distributed Resource Plan proceeding), Illinois (NextGrid proceeding), Maryland (Public Conference 44), and Ohio (Power Forward proceeding).

V. SUMMARY AND RECOMMENDATIONS

Q. Please summarize your testimony.

A. I recommend that the Commission hold a distinct proceeding to consider the Company's (and other electric utilities') grid modernization investment proposals. I make this recommendation because:

- Grid modernization investments are very large and distinct in character from customary, business-as-usual grid investments;
- Stakeholder participation will better align Company grid modernization capabilities and investments with stakeholder priorities;
- Application of the "used and useful" standard after large grid modernization investments have been made is inadequate to protect consumer and environmental interests; and
- It is likely Commission review will deliver a better grid modernization benefit-cost ratio for customers, communities, and the environment than no such review.

I described several grid modernization capabilities my experience indicates offer significant customer and environmental benefit potential. However, I cautioned that the benefits actually delivered to customers and communities from grid modernization investments vary widely by utility. I also noted that many of the grid modernization capabilities offering significant benefit potential -- including IVVC, time-varying rates, conservation from various sources, demand response, third party energy management, and increases in distributed renewable generation hosting capacity – are not mentioned

anywhere in the Company's rate case or smart grid technology plan. I also described commonly-identified grid modernization plan implementation issues which stakeholder participation can help solve, from under-estimated costs and sub-optimized benefits to the throughput incentive, rate case timing, and performance measurement programs.

I finished my testimony with descriptions of various regulatory processes state regulators are using to review grid modernization plans, including forward test years, certifications for public convenience and necessity, and specially-convened proceedings. I also noted that none of these are currently available in North Carolina.

Q. What are your recommendations to the Commission in this case?

A. I have two recommendations.

1) I recommend the Commission establish a distinct proceeding to address and resolve the issues presented by the Company's grid modernization investment proposals, including all of the issues identified in this testimony; and

2) I recommend the Commission require all future grid investment proposals which are outside customary grid needs be subject to such distinct proceedings.

Q. Does this conclude your direct testimony?

A. Yes, it does.

Curriculum Vitae -- Paul J. Alvarez MM, NPDP

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Profile

After 15 years in Fortune 500 product development and product management, including P&L responsibility, Mr. Alvarez entered the utility industry by way of demand-side management rate and program development, marketing, and impact measurement in 2001. He has since designed renewable portfolio standard compliance and distributed generation rates and incentive programs. These experiences led to unique projects involving the measurement of grid modernization costs and benefits (energy, capacity, operating savings, revenue capture, reliability, environmental, and customer experience), which revealed the limitations of current utility regulatory and governance models. Mr. Alvarez currently serves as the President of the Wired Group, a boutique consultancy serving consumer and environmental advocates, regulators, associations, and suppliers.

Research Projects, Thought Leadership, Regulatory Appearances

Evaluation of Southern California Edison's Request to Invest $2.3 Billion in its Grid to Accommodate Distributed Energy Resources. Testimony before the California Public Utilities Commission on behalf of The Utility Reform Network. A16-09-001. May 2, 2017.

Evaluation of Kentucky Utilities/Louisville Gas & Electric Smart Meter Deployment Plan. Testimony before the Kentucky Public Service Commission on behalf of the Kentucky Attorney General in 2016-00370/2016-00371. March 3, 2017

Evaluation of National Grid's Massachusetts Smart Meter Deployment Plan. Testimony before the Massachusetts Department of Public Utilities on behalf of the Massachusetts Attorney General in 15-120. March 10, 2017.

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Regulatory Reform Proposal to Base a Significant Portion of Utility Compensation on Performance in the Public Interest. Testimony before the Maryland PSC on behalf of the Coalition for Utility Reform, case 9361. December 8, 2014.

Best Practices in Grid Modernization Capability Optimization: Visioning, Strategic Planning, and New Capability Portfolio Management. Top-5 US utility; client confidential. 2014.

Smart Grid Economic and Environmental Benefits: A Review and Synthesis of Research on Smart Grid Benefits and Costs. Secondary research report prepared for the Smart Grid Consumer Collaborative. October 8, 2013. Companion piece: Smart Grid Technical and Economic Concepts for Consumers.

Duke Energy Ohio Smart Grid Audit and Assessment. Primary research report prepared for the Public Utilities Commission of Ohio case 10-2326-GE. June 30, 2011.

SmartGridCity™ Demonstration Project Evaluation Summary. Primary research report prepared for Xcel Energy. Colorado Public Utilities Commission case 11A-1001E. October 21, 2011.

Books

Smart Grid Hype & Reality: A Systems Approach to Maximizing Customer Return on Utility Investment. First edition. ISBN 978-0-615-88795-1. Wired Group Publishing. 327 pages. 2014.

Noteworthy Publications

Busting Myths: Investor-Owned Utility Performance Can be Credibly Benchmarked. With Joel Leonard. Electricity Journal. In production for November, 2017 issue.

Price Cap Electric Ratemaking: Does it Merit Consideration? With Bill Steele. Electricity Journal. In production for October, 2017 issue.

Integrated Distribution Planning: An Idea Whose Time has Come. Public Utilities Fortnightly. November, 2014; also International Confederation of Energy Regulators Chronicle, 3rd Ed, March, 2015

Maximizing Customer Benefits: Performance Measurement and Action Steps for Smart Grid Investments. Public Utilities Fortnightly. January, 2012.

Buying Into Solar: Rewards, Challenges, and Options for Rate-Based Investments. Public Utilities Fortnightly. December, 2009.

Smart Grid Regulation: Why Should We Switch to Performance-based Compensation? Smart Grid News. August 15, 2014.

A Better Way to Recover Smart Grid Costs. Smart Grid News. September 3, 2014.

Is This the Future? Simple Methods for Smart Grid Regulation. Smart Grid News. October 2, 2014.

The True Cost of Smart Grid Capabilities. Intelligent Utility. June 30, 2014.

Notable Presentations

Public Utilities Commission of Ohio, Power Forward Proceeding Phase 2. *Getting a Smart Grid for FREE.* Columbus, Ohio. July 26, 2017.

NASUCA Mid-Year Meeting. *Using Performance Benchmarking to Gain Leverage in an "Infrastructure Oriented" Environment.* Denver. June 6, 2017.

NARUC Committee on Energy Resources and the Environment. *How big data can lead to better decisions for utilities, customers, and regulators*. Washington DC. February 15, 2016.

NARUC Subcommittee on Electricity. *Maximizing Smart Grid Customer Benefits: Measurement and Other Implications for Investor-Owned Utilities and Regulators.* St. Louis. November 13, 2011.

NARUC Subcommittee on Energy Resources and the Environment. *The Distributed Generation (R)Evolution.* Orlando. November 17, 2013.

NASUCA 2013 Annual Conference. *A Review and Synthesis of Research on Smart Grid Benefits and Costs.* Orlando. November 18, 2013.

Mid-Atlantic Distributed Resource Initiative. *Smart Grid Deployment Evaluations: Findings and Implications for Regulators and Utilities.* Philadelphia. April 20, 2012

IEEE Power and Energy Society, ISGT 2013. *Distribution Performance Measures that Drive Customer Benefits.* Washington DC. February 26.

National Conference of Regulatory Attorneys 2014 Annual Meeting. *Smart Grid Hype & Reality.* Columbus, Ohio. June 16.

DistribuTECH 2012. *Lessons Learned: Utility and Regulator Perspectives.* Panel Moderator. January 25.

DistribuTECH 2012. *Optimizing the Value of Smart Grid Investments.* Half-day course. January 23.

Canadian Electric Institute 2013 Annual Distribution Conference. *The (Smart Grid) Story So Far: Costs, Benefits, Risks, Best Practices, and Missed Opportunities.* Keynote. Toronto, Canada. January 23.

Great Lakes Smart Grid Symposium. *What Smart Grid Deployment Evaluations are Telling Us.* Chicago. September 26, 2012.

Teaching

Post-graduate Adjunct Professor. University of Colorado, Global Energy Management Program. Course: Renewable Energy Commercialization -- Electric Technologies, Markets, and Policy.

Guest Lecturer. Michigan State University, Institute for Public Utilities. Courses: Performance Measurement of Distribution Utility Businesses; Introduction to Grid Modernization.

Education

Master's Degree in Management, 1991, Kellogg School of Management, Northwestern University. Concentrations: Accounting, Finance, Information Systems, and International Business.

Bachelor's Degree in Business Administration, 1984, Kelley School of Business, Indiana University. Concentrations: Marketing and Finance.

Certifications

New Product Development Professional. Product Development and Management Association. 2007.

CERTIFICATE OF SERVICE

I hereby certify that all persons on the docket service list have been served true and accurate copies of the foregoing Direct Testimony of Paul J. Alvarez by first class United States mail, postage prepaid, or by email transmission with the party's consent.

This the 18th day of October, 2017.

/s/ John Finnigan

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John Finnigan